

Optimal Solution for **Mass Transfer Processes**



TOP SOLUTION PROVIDER FOR MASS TRANSFER PROCESSES

Most of the refinery, petrochemical, and chemical processes have a distillation system. Distillation systems consume approximately 50% of the total plant energy. Oil & Gas and Chemical plants are always looking to improve energy efficiency, product quality, and capacity of their distillation systems.

Benit M is passionate to find the solutions from basic design to the column design by applying its accumulated knowledge of up-to-date technologies of chemical processes and tower internals. Our expertise is in two major fields: (1) distillation engineering and (2) water recovery/desalination.

Introduction

Benit M was established in March 2016 in Ulsan, Korea. As a mass transfer specialist in distillation, most of the projects Benit M performs are to improve the separation efficiency, to reduce energy consumption, and to separate the chemicals which have thermodynamic difficulties.

To overcome the global water challenges, Benit M provides the novel technology to improve the existing water recovery and desalination technologies.

We are committed to spreading the technology and expertise in the mass transfer around the globe while sustaining the true quality of the values.

Benit M Performs

- ✓ Distillation process simulation and PROCESS DESIGN
- ✓ Distillation process TROUBLESHOOTING
- ✓ Operation analysis and CONSULTING for optimization
- ✓ FEASIBILITY STUDY for improvement of distillation process
- ✓ Mass transfer equipment DETAIL DESIGN REVIEW
- ✓ Mass transfer equipment fabrication/installation INSPECTION

Accumulated Experiences in Mass Transfer Process Design

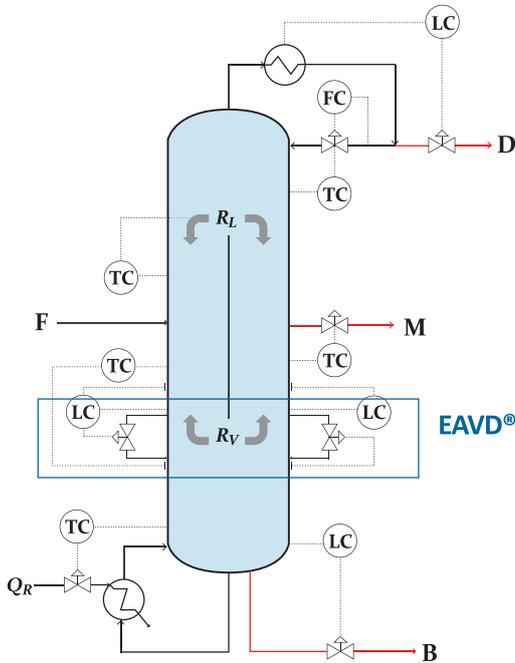
- ✓ Conventional, Azeotropic, DWC, Batch, Extractive, Reactive, Distillation, Absorber, Extraction, etc.
- ✓ Acid Gas Removal and CO₂ Capture
- ✓ Solvent Recovery
- ✓ Water Recovery
- ✓ Desalination



DISTILLATION ENGINEERING

Dividing Wall Column with EAVD®

VIDEO
LINK



Advantages of Dividing Wall Column (DWC)

- 15-50% energy saving by converting two conventional columns to DWC
- Higher purity of middle product
- Reduce investment cost
- Smaller space/area

Problems in Conventional DWC

**By nature: liquid rate \uparrow ; vapor rate \downarrow
Vapor split control is mandatory for optimal operation.**

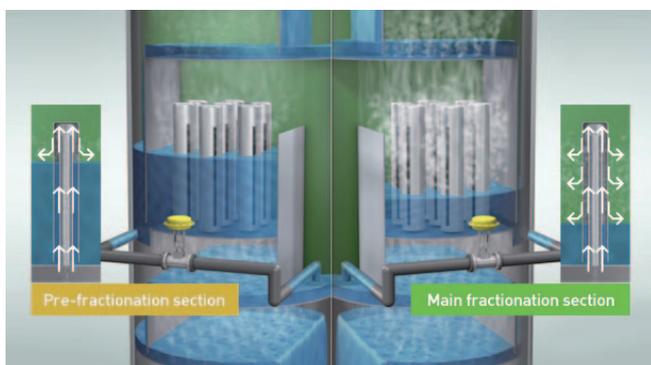
- Liquid and vapor split ratios play a very important role in the design of DWC (Benyounes et al., 2015).
- The energy required for separation in DWC depends on using an optimal vapor split (Dwivedi et al., 2012).
- A small deviation of vapor split can significantly reduce DWC energy efficiency (Lee et al., 2011).

Noteworthy Benefits of Enhanced Active Vapor Distributor (EAVD®)

PATENT REGISTERED FEB. 02, 2017

- ✓ Optimal vapor split ratio of the DWC can be achieved accordingly
- ✓ High energy saving by applying optimal DWC design can be maintained
- ✓ Wide operating range of packed column by maintaining uniform vapor distribution

How it works



The caps covering the chimney, have opening area for the vapor flow path which can be simply adjusted by altering the liquid level on the chimney tray. Therefore, EAVD® enables efficient vapor split ratio control during DWC operation.

Published Articles



DOI: 10.1021/acs.iecr.7b01023
IECR, 2017, 56, 6493-6498

Hydraulic Driven Active Vapor Distributor for Enhancing Operability of Dividing Wall Column



DOI: 10.3303/CET1869140
CET, 2018, 69, 835-840

Optimal Operation of a Dividing Wall Column using Enhanced Active Vapor Distributor



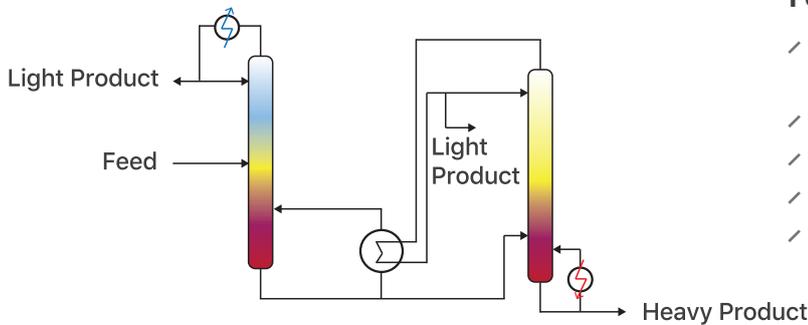
DOI: 10.1016/j.cherd.2019.02.038
CHERD, 2019, 144, 512-519

Optimal operation of a dividing wall column using enhanced active vapor distributor

DISTILLATION ENGINEERING

Multi-Effect Distillation

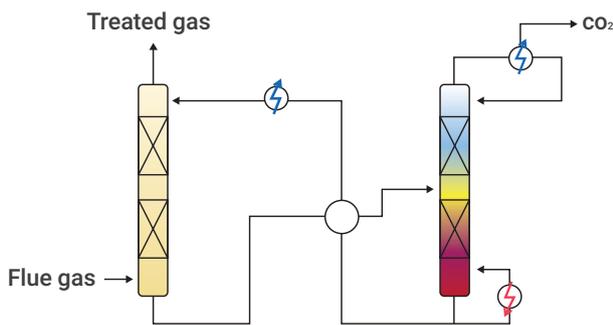
PATENT REGISTERED FEB. 01, 2019



Features and Advantages

- ✓ Combination of azeotropic distillation - conventional distillation
- ✓ An effective method of utilizing waste heat
- ✓ Minimize heat loss
- ✓ Energy saving by 35%-65% (double, triple)
- ✓ Applications : Methanol dehydration, Acetic acid dehydration, etc

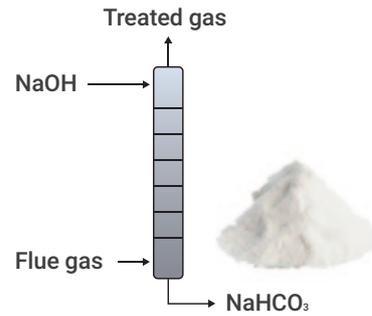
CO₂ Capture



Basic Design package for Solvent-Based CO₂ Capture

- ✓ High efficiency of CO₂ removal
- ✓ Cost-effective design
- ✓ Wide operating range

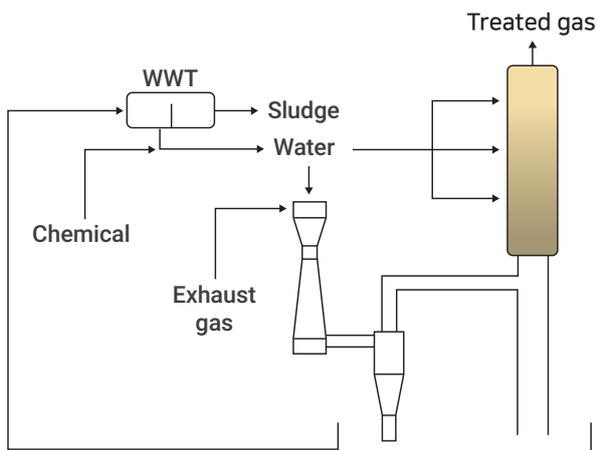
CO₂ Utilization



Carbonation Column Design for CO₂ Utilization

- ✓ Valuable product of CO₂ utilization
- ✓ Special tower internal design
- ✓ No fouling

DeSO_x Scrubbing Process



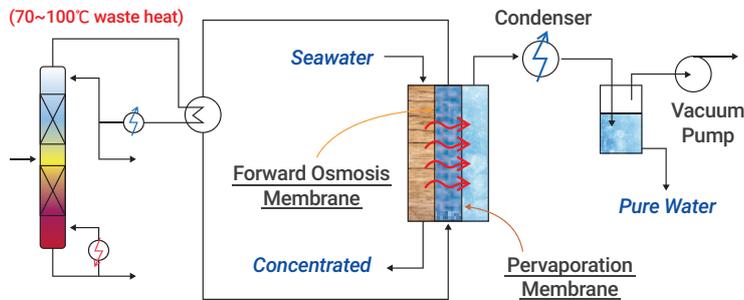
Basic Design package for SO_x Scrubber

- ✓ SO_x emission level is suitable with ECA regulation : SO_x ppmV/CO₂ %V < 2.0
- ✓ Higher distribution quality
- ✓ Enhanced DeSO_x scrubbing performance for the same footprint

WATER RECOVERY / DESALINATION

Forward Osmosis Combined Membrane

PATENT REGISTERED APR. 16, 2019

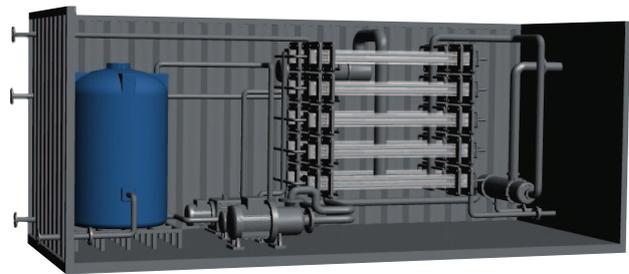


Features and Advantages

- ✓ Utilize low temperature waste heat
- ✓ Water quality : <math>< 1 \mu\text{S/cm}</math> (in-situ analysis)
- ✓ Salt water as draw solution
- ✓ Draw solution regeneration in one module
- ✓ High performance/flux of FO can be maintained
- ✓ Application : water recovery from wastewater
seawater desalination

How it works

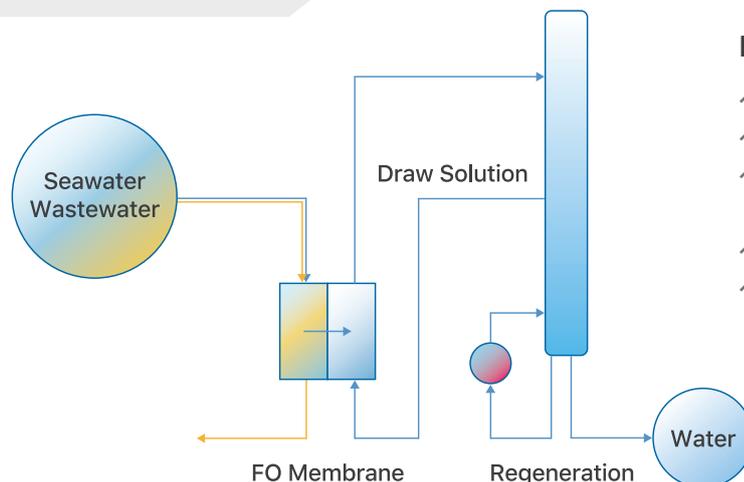
- ✓ The combined membrane consists of FO and Pervaporation (PV) in one module.
- ✓ When water passes from the feed solution to the draw solution, water product is simultaneously removed from draw solution through the PV membrane.
- ✓ It eliminates the need for a separate draw solution recovery system since regeneration is built-in in one system.
- ✓ Low-temperature heat source can be used because PV is operating under the vacuum condition.
- ✓ The integration with distillation in chemical plants might be beneficial for zero-energy water production.



FO combined membrane desalination, 10 m³/day

Forward Osmosis – Distillation Hybrid

PATENT REGISTERED APR. 27, 2018



Features and Advantages

- ✓ Ammonium Bicarbonate draw solution
- ✓ Utilize low temperature waste heat
- ✓ Low steam consumption,
0.2~0.35 ton steam/ton-water product
- ✓ No plugging or fouling trouble
- ✓ Application : Water recovery from wastewater
Seawater desalination

PORTFOLIO OF RELEVANT PROJECTS

Absorber Design for CO₂ Capture Process

The client intended to test the special solvent and they were expecting to compare the performance with the conventional amine system by altering the gas feed rate. The EAVD[®] was installed in the absorber to cover the wide operating range of absorption process while maintaining the high efficiency.

MeOH Recovery in Batch Distillation column

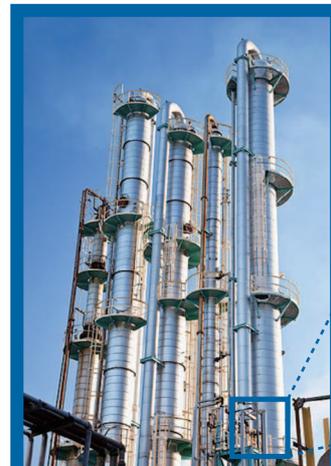
It is well-known in the batch column operation that significant variation of vapor rate occurs over a different period among foreruns, main, and final cuts. By applying the unique EAVD[®] design, the client found out the performance of a packed distillation column was stable without losing its efficiency from the beginning to the end of the batch operation.

LPG-Amine Extraction Process Basic Design

The client used to have capacity limitation during the liquid-liquid extractor operation. Based on the research conducted by Benit M, it was found that the existing tray design and column diameter was not enough to cover the desired LPG-amine loading. Benit M supplied the retrofit design of the extraction process, and as a result, the proposed LPG-amine process was able to cover the desired loading.

Process and Equipment Design of NaHCO₃ Reaction Column

Fouling is a big headache for the client during the production of NaHCO₃, it commonly occurs due to the solid particle formation during the reaction. To overcome this issue, Benit M delivered process modification including special tower internal design to minimize the fouling tendency. The longer operation of reaction column was well-achieved.



EAVD[®]

“ From the simple idea to the Industrial Market ”

NCC C₂ Fractionation Column Revamp Study

The client asked Benit M to evaluate the technical proposals of tower internal suppliers for C₂ fractionation process in NCC Plant. Benit M performed not only technical bid evaluation but also the recommendation of high-performance tower internal design. As the outcome, the client was able to achieve the successful operation at the target loading.

Troubleshooting of VOC Removal Process in PTA Plant

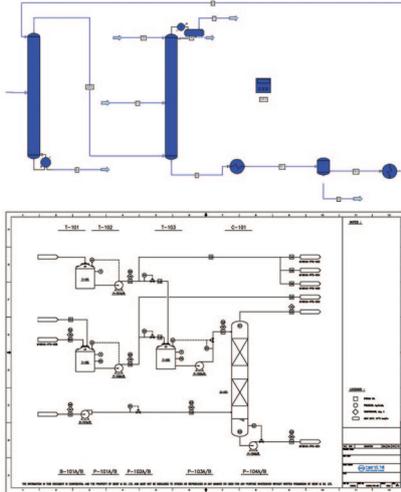
The environmental pollution problem has occurred in the client's PTA plant. Although the VOC content in the feed was only a few ppm, the effluent gas could not meet the environmental regulations. Benit M concluded according to its accumulated experiences that VOC accumulation was occurring because of the existence of multiple azeotropic mixtures, in which the client didn't realize earlier. Benit M provided the solution to remove VOC by utilizing the existing equipment.

We are

enthusiastic to deliver the optimal solution through our accumulated knowledge and experiences in mass transfer processes.

R&D activities to deliver the optimal solution with outstanding value

Not only for the services in distillation engineering, but the R&D center also will enable Benit M to take step forward in the worthwhile area such as water recovery and desalination with high value and sophisticated technology. Benit M continuously conducts profound research resulting in acquiring worldwide patent rights.



To spread the technology and expertise in the mass transfer processes around the globe

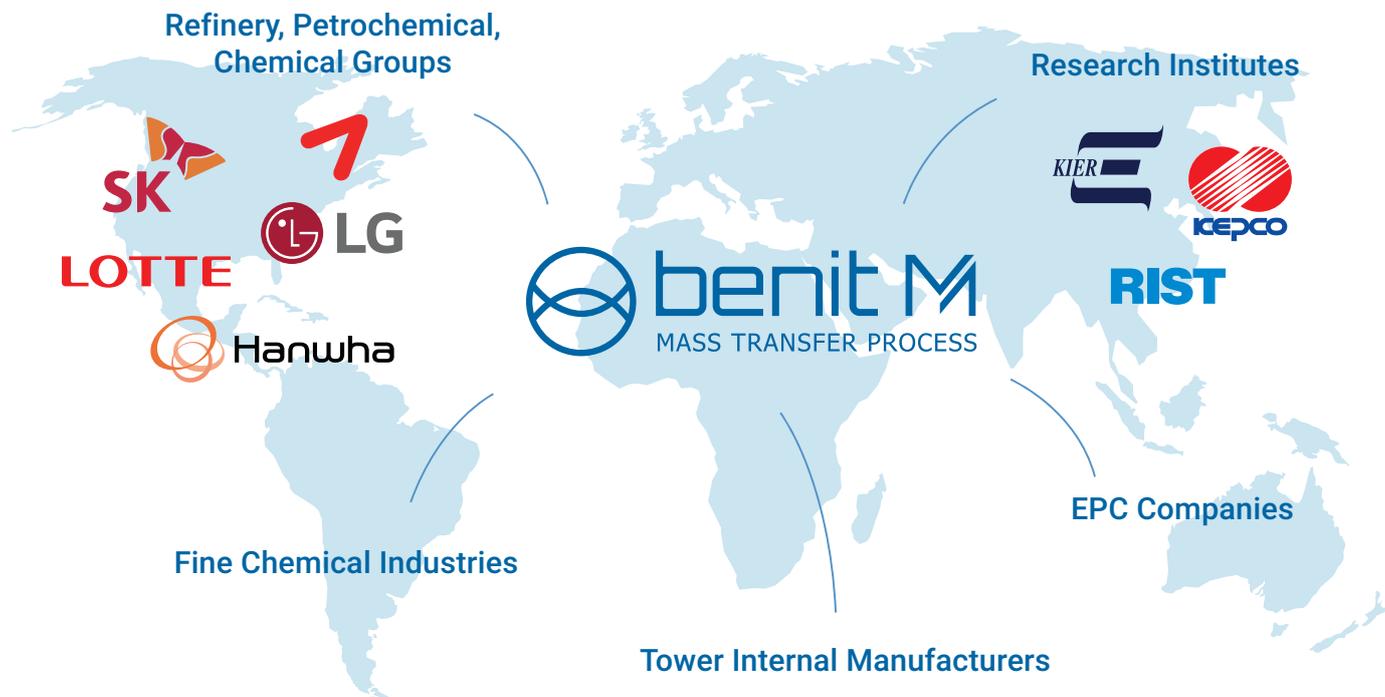
We are actively joined the conferences and exhibition to spread the knowledge and innovation related to Benit M's special expertise. Moreover, we are passionate to learn up-to-date technologies which support the needs of our innovation, know-how and creativity when handling the clients' problem in mass transfer processes.



Distillation & Absorption Conference 2018



Oil & Gas Asia 2019 Exhibition



Areas of Expertise

- ✓ Refinery, Petrochemical, Chemical, Fine Chemical
- ✓ Acid Gas Removal and CO₂ Capture
- ✓ Solvent Recovery
- ✓ Water Recovery
- ✓ Desalination



Activities

- ✓ Mass Transfer Process Engineering
- ✓ Operation Analysis, Troubleshooting
- ✓ Design and Operation Consulting
- ✓ Optimization for Energy Saving and Debottlenecking
- ✓ Column and Tower Internals Engineering Documents Review

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